Apparatus and Methods for Home Networking

By Inventor
Dan Kikinis

Field of the Invention

The present invention is in the area of multimedia computing and communication systems, and pertains more particularly to networking with home systems to allow sharing of functions ad devices among individual PCs connected to a home network.

Cross-Reference to Related Applications

The present application is related to copending patent application S/N 08/744,287 as a Continuation-in Part, and incorporates all of the prior application by reference.

Background of the Invention

Continuing development of hardware and applications for home computing, coupled with explosive growth of the global network called the Internet has motivated more and more people to have at least one computer in the home or in a small business. For the purpose of description and teaching in the present application, the concept of a home environment is used. The inventor intends this concept to include any equivalent environment, such as a small business, non-profit organization, government organization, and the loke, which might use systems of the sort taught herein. The references to home systems and home computers and the like are meant to include all such situations.

Many people in fact, have two or more computers at home, and many more are contemplating adding at least a second computer. A parallel trend is to adding one or more computerized appliances in addition to a home computer. These appliances are such as Internet Telephones, computerized set-top boxes, and the like.

A problem with more than one computer or network using-appliance, such as an Internet Telephone, WEB browsing set top box, etc. at home is that, just like in the office,

a need quickly becomes apparent for connecting the computers in a network of some sort so resources like a printer and a modem may be shared. Still, even if a network were provided allowing sharing of common devices like a printer, allowing each computer to have Internet access is a problem. Given one Internet Service Provider (ISP) and one Internet account, even if several computers have simultaneous access to the Internet provider's server, only one user at a time may browse the Internet. There are traditional, but expensive solutions. Two or more Internet accounts could be maintained, for example, and each computer could have its own modem and dedicated telephone line. For a single family having multiple home computers however, this is not a good solution.

What is needed is an apparatus and methods allowing several computers to share common resources, such as printers, faxes, voice mail, and so forth, while allowing simultaneous users to connect to and use the Internet.

Another difficulty with existing home network systems, is that proposed multimedia integrated systems in the current art depend typically on methods that are not compatible with existing home and office wiring. As a result, such systems are expensive to implement and limited in operation. A system is needed for real-time multimedia data distribution which ca make use of existing telephone wiring of most homes and offices.

Summary of the Invention

In a preferred embodiment a home server unit is provided comprising a communication bus for connecting digital devices within the home server interface unit; a CPU coupled to the bus for managing activities of the hone server unit; a random access memory (RAM) coupled to the bus for temporary and dynamic data and instruction storage; a read-only memory (ROM) coupled to the bus for non-volatile storage of an operating system; a hub circuit coupled to the bus and having network ports for connecting to personal computers; an input/output I/O interface circuit coupled to the bus and having at least one parallel port for connecting to printing and scanning devices; and a bridge adapter unit coupled to the bus and having at least one port adapted for connecting to a wide area network and at least one port adapted for connecting to a

telephony device. The CPU, executing stored control routines manages data transfers between connected PCs and one or more service providers accessed via the wide-area network.

In alternative embodiments of the home server unit one or more of the hub circuit, the I/O interface circuit, and the bridge adapter unit are implemented as plug-in cards, and the bus has a card slot for receiving the one or more plug-in cards. Also in alternative embodiments of the home server unit the CPU, executing stored control routines, provides simultaneous Internet access for two or more PCs connected to the home server unit. Other functions provided by the home server through the PU and stored control routines include telephone exchange services for two or more telephony devices connected to the home server unit, receiving incoming facsimile transmissions, and routing such transmissions to any one of connected PCs or connected printers, according to preprogrammed instructions, and providing access to a remote server over the port adapted for wide area network connection, so one or more connected PCs may use storage space on the remote server transparently to the user.

The home server unit according to embodiments of the invention solves the existing problem of providing wide area network access to multiple computerized appliances without requiring multiple service accounts.

In an alternative embodiment of the invention a multimedia data distribution system is provided, comprising a distribution system adapted to distribute and deliver Asynchronous Transfer Mode signals to the level of an individual home network bus; a micro-PBX connected to the distribution system and to the home network bus; and a converter connected to the home network bus and having an outlet adapted for connecting to conventional single media and multimedia electronic devices. The micro-PBX is adapted to translate between the ATM protocol and a non-ATM data protocol on the home network bus, and to manage the home network bus as a carrier Sense Multiple Access/Collision Detect (CSMA/CD) type bus, and the converter is adapted to convert signals on the home network bus to a form required by one of the single media and multimedia electronic devices. The single media and multimedia electronic devices include telephones, personal computers (with adapter cards), fax machines, and

televisions running through set top boxes. In this embodiment and aspect, multimedia distribution is accomplished an a relatively inexpensive manner, and by using existing telephone wiring available in most homes and businesses.

Brief Description of the Drawings

Fig. 1 is a block diagram of a home network according to an embodiment of the present invention.

Fig. 2 is a line-by-line listing providing routing examples for the network system of Fig. 1.

Fig. 3 is a block diagram of a multimedia network system according to an alternative embodiment of the present invention.

Description of the Preferred Embodiments

Fig. 1 is a block diagram of a home network according to an embodiment of the present invention. A Home Server Unit 100 according to a preferred embodiment of the present invention comprises a CPU 104, an I/O circuit 102 (which may be a single chip), random access memory (RAM) 106, a read-only memory (ROM) 107, and a hub circuit 103. The ROM may in some embodiments be an alterable ROM (AROM) so upgrades in operating systems and the like may be made. There is also an optional hard disk drive 105. The digital elements of Home Sever Unit 100 are connected by a communications bus 115, which may be one or another of several buses known in the art, such as AT, PCI, and so forth. A plug-in interface 11 on bus 115, similar to or the same as an expansion port interface in a PC, is provided to accept one or another of several different bridge adapter units 101.

Home Server Unit 100 is typically a box that may be located in any convenient location in the home or other environment, with ports for interfacing to other units and

services. For example, hub circuit 103 connects to multiple ports 114 for connection to multiple PCs. Four ports are shown and two are used in this example for connection to PCs 130 and 131. In the embodiment shown hub circuit 103 is also fashioned as a plug-in unit with a card slot 15 provided, so circuitry may be modularly adapted to a user's specific needs.

I/O circuitry 102 connects to at least one parallel port 113 for connecting to peripheral devices such as a printer 132 shown. Other peripherals, such as a second printer (color printer), a scanner, and the like may be connected from one of the I/O ports. Bridge Adapter Unit 101 provides circuitry with ports 111 for connecting to a communications network 110 and ports 112 for connecting to telephony equipment such as facsimile machine 141 and telephone 140. In some embodiments a large number of telephone ports may be provided, and Bridge Adapter Unit 101 may function as a PBX exchange.

Communications network 110 may be for example an ISDN connection to a local telephone company switch, in which case Bridge Adapter Unit 101 will be adapted for ISDN protocol. Communications network 110 may also be an analog telephone link, a cable connection, an Asymmetric Subscriber Digital Line (ASDL), or other link. The point of plug-in modularity for bridge adapter unit 101 is that a user may adapt his or her Home Server Unit 100 according to the service available from the home, and change at a later time if a new or different communication service to the home becomes available.

At the service provider's end a Multi-Bridge Adapter Unit 120 provides for receiving and processing data packets delivered over network 110, and for sending data packets from the service provider's end to the Home Server Unit, identified for the PC or peripheral device to which each transmission is intended. For example, facsimile messages may be delivered to unit 100 at Bridge Adapter Unit 101 via network 110, and be routed to facsimile machine 141. Alternatively, incoming faxes could be routed to laser printer 132 via I/O circuitry 102.

Returning again to the service provider's end of the system, Multi-Bridge Adapter Unit 120 connects to an Ethernet™ backbone 121 (in this particular embodiment) to

which various equipment may be interfaced, such as a server 123 shown and a support technician workstation 122.

In a preferred embodiment of the invention control routines 13 are provided and stored in AROM 107 to be loaded into RAM 105 on start-up of the Home Server Unit. These routines provide for control of all elements connected to bus 115, and for conversion and routing of data among the various elements and ports. A salient advantage of the invention in this respect is that data protocols of any sort may be utilized and accommodated.

Fig. 2 provides routing examples which may be accomplished by Home Server Unit 100. Data protocols (network protocols) that may be accommodated are represented in Fig. 2 by NP), NP1, and NP2. NP0 may be, for example TCP/IP protocol, NP1 Novell Network protocol., and NP2 MSNet. Lines 210 and 211 represent PC to PC communication through hub circuitry 103 (which may be a single chip). Data from PC 130, for example, may be received in NP0 and converted to NP1 for transmission to PC131. The conversion would also be made in the reverse, and CPU 104, executing routines called from RAM 106, handles the conversion and routing. Different versions of control routines according to the invention may be available for loading to AROM 107, depending, among other things, on the network adapters and communication protocols of PCs to be connected.

Lines 220 through 223 in Fig. 2 represent PC to printer communication. Data for printer 132 received from either of PC 130 and 131 at hub 103 is converted as necessary by CPU 104 executing routines 13 and sent to printer 132 via I/O circuitry 102 and port 113. Printer data may be queued and buffered using any of the storage devices (RAM 106, optional hard disk drive 105, or even AROM 107), or any combination.

Lines 230 through 233 represent communication between PCs and the Internet. In this case TCP/IP protocol is received from one of the PCs and processed into AU 101 for transmission to ISP equipment AU 120. Return data, also TCP/IP, is sent from AU 120 via network 110 to AU 101, then routed to the associated PC by CPU 104 executing control routines 13.

Finally, lines 240 through 244 represent communication between a PC and the Internet service provider (ISP) by a different (non TCP) protocol.

In the embodiment shown PCs connected through Adapter Unit 100 to a service provider, depending on control routines provided, may have access to disk space, such as on server 123 connected to Ethernet backbone 121. This is an additional benefit providing a transparent extra high-capacity drive for each user.

Fig. 3 is a block diagram of a multimedia network system in an alternative embodiment of the present invention. The system of Fig. 3 distributes multimedia real-time data, both on-demand and broadcast, as well as computer and telephony data, all over the same system, making use of existing telephone wiring in and to a home or office. This is done in an embodiment of the invention by adapting existing hardware elements and data protocols in a new and inventive architecture not before implemented, and in a manner to provide enhanced performance over existing and known proposed systems for multimedia distribution.

Typical existing networks for multimedia data distribution are of a sort called system parallel, which requires duplication of hardware and data paths, resulting in high cost. Some system offering a form of integration require expensive new cabling. The system of the present invention avoids such duplication and allows use of existing telephone system wiring in virtually all cases, both in and to the house.

In Fig. 3 network cloud 360 represents worldwide data sources, and link 341 is a high speed Asynchronous Transfer Mode (ATM) link operating on a high-speed path such as a fiber-optic line. ATM is not described in detail in this specification, as it is a well-known network protocol and system in the art of telephony, and available to the inventor as well as to all those with skill in the art.

Link 341 leads to a subdivision head-end 342 providing distribution to individual homes and businesses. One such individual unit destination is represented by unit 300, which may be a typical apartment , home, or office. The placement of such subdivision head-ends in embodiments of the invention is a function of distance capability for hardware and data protocols used.

An ATM router switch 340 in subdivision head-end 342 receives the ATM data packets from network 360 and distributes them to subsection routers 330a through 330c via internal wring such as link 343a. It will be apparent to those with skill in the art that there may be many more (or fewer) than the three subsection routers shown, but three will be more than sufficient to teach the invention.

A satellite dish 350 is an optional component of subdivision head-end 342, and when present in embodiments of the invention is used to receive digitally-encoded satellite broadcasts. These signals are downloaded via link 351 to a converter 352, which de-multiplexes the transport strings and converts them into ATM packets which are provided over link 353 to ATM router switch 340 for distribution according to data in the ATM packets.

From subdivision head-end 342 data is distributed from each of multiple subsection routers to individual homes and businesses. It will apparent to those with skill in the art that there may be tens, hundreds or even thousands of links to individual destinations, but only one, link 320, is shown herein to adequately describe the present invention.

Link 320 is typically existing copper wiring and is based on the well-known Asynchronous Digital Subscriber Line (ADSL) technology. At the individual home or business 300 a micro-PBX 301 receives the ADSL signals, translates them, and retransmits them on internal wiring represented in Fig. 3 as links 302a through 302d.

In most existing home or office wiring the internal wires are copper, and not all connections are of the star-type, wherein each internal outlet has a separate wire from the receiving junction box. Rather the internal wiring may well be, and usually is, a tree-type network, wherein some outlets stem from other internal trunks lines. It is very common, in fact, for new outlets in home and office situations to be daisy-chained from existing wiring and outlets, rather than being taken from the initial junction box to the home or office. This existing situation is a formidable impediment to the kinds of integrating network solutions that have been so far proposed, which typically require separate lines to each outlet. In that circumstance, existing wiring has to be completely replaced at a substantial penalty in time and cost. In embodiments of the present invention, as

described in more detail below, the existing wiring can stay in place and is used without impediment.

There are, as well-known in the art, a number of different requirements for data within a home or business, and several of these, though not all, are illustrated in Fig.3. Shown in Fig. 3, for example, are a television 303 connected to a set-top box 304; a computer 310, a fax machine 307, and a telephone 309. There may, of course, be more than one of each of the devices shown, and other devices as well.

Existing internal wiring of unit 100 used in the illustrated embodiment of the present invention is illustrated as lines 302 a- 302c. For the purpose of illustrating the fact of tree-type architecture, lines 302b and 302c are shown as emanating from micro-PBX 301, while lines 302a and 302d proceed from lines 302b and 302c respectively.

In embodiments of the present invention micro-PBX is a converter and bus management system adapted to receive ATM data for all of the devices in the unit 100 to which the micro-PBX is connected, and to route the data in a different protocol onto the internal bus. Micro-PBX 301 operates the in-house wiring as a bus system under a multiple access points type protocol, such as Carrier Sense Multi Access/ Collision Detect (CSMA/CD) protocol. This is a protocol type well-known in the art that was also the basis of original Ethernet™ systems. In this system type, the sending device first listens on the bus for line free before sending data, then checks for collision. The inventor has selected this type bus management precisely because it allows use of the existing tree-type wiring structure of phone lines of most homes and businesses. However other implementations are also possible, such as modulated carriers etc. In micro-PBX 301 the ATM packets are converted to, in this case, TCP/IP protocol, although TCP/IP is not the only choice. Most local-area-network-type protocols cold be used easily. Any type of high frequency modulation or direct digital connection could be used that is compatible with asymmetric star wiring (a.k.a. Christmas tree wiring). This also allows micro-PBX 301 to be added at almost any convenient point on the in-house bus.

Within unit 300 converters are provided for each device and outlet to convert the incoming TCP/IP data to the form required by each connected device. For example,

television 303 is connected to micro-PBX through a set-top box 304 (which happens to be under the TV in this instance), and box 304 is adapted to receive video stream data addressed to a number assigned to the set-top box, and to translate that data stream to a video presentation playable on television 303.

In the case of fax machine 307, an adapter box 305a connects to in-house wiring 305a and converts incoming data on line 302c and addressed to the fax machine into an analog data stream on line 307 to the fax machine. Similarly a converter box 305b converts data on line 302b into an analog data stream on line 308 for voice communication via telephone 309. Conversion is, of course, bi-directional.

Conversion boxes 305a and 305b and like converter boxes in various embodiments of the present invention are adapted for mounting to existing telephone jack outlets presenting a new outlet for connecting to the specific device (fax, phone, etc.).

In the case of personal computer (PC) 310, conversion is accomplished in an expansion card compatible with any expansion slot in the computer, allowing the multimedia PC to be used both for telephony functions and as a WEB browser via the in-house bus.

In the embodiment of the invention illustrated with reference to Fig. 3, the Micro-PBX and converter boxes need power. Power may be supplied locally at each box by a power converter plugged into a power outlet (not shown). In a preferred embodiment, power is supplied at, for example, 48 volts across two lines of the in-house wiring. The power supply voltage is imposed by a transformer/converter box (not shown) that may be placed at any convenient telephone outlet jack outlet and connected to the power mains system available close by.

Another advantage of the illustrated system is that, as each adapter unit in the system, for each specific device, has an assigned number, calls may be placed between specific in-house devices via micro-PBX 301, which may accomplish many PBX functions. Another advantage is that, by placing a new converter box, new external access numbers may be assigned by a local telephone company remotely by reprogramming micro-PBX 301 on-line.

In embodiments of the present invention, once subdivision headers and subsection routers are available, conversion of any house, apartment, or small business unit is relatively simple. A micro-PBX is installed at the position of the existing telephone junction box where outside telephone service enters the premises (a.k.a. service demarcation). A power adapter is installed to provide the necessary power voltage on the in-house network, which is simply a matter of plugging in a power box at any convenient power outlet and connecting an outlet telephone jack into the house network at any conveient outlet port. Such a unit could also contain a back-up power source for case of power failure.

As a final step, PCs are supplied with expansion cards, TVs with compatible set-top boxes, and converter boxes (see 305a and 305b above) are mounted to existing telephone jack outlets convenient to the equipment to be connected. The conversion is quick and simple, and may, in most cases, easily be performed by the end user with little outlay of time and material.

It will be apparent to those with skill in the art that there may be many alterations in the embodiments of the invention shown and described without departing from the spirit and scope of the invention. Many variations have been described above, such as an ability to handle any network protocol between various pieces of connected equipment. There are also many variations in the control routines that may be used, and in the hardware provided as Adapter Unit 101.

In the aspect of invention described with reference to Fig. 3, there are similarly many alterations that might be made without departing from the spirit and scope of the invention. Many of these options have already been described above. For example, there is a broad variance in PBX functions that may be utilized by micro-PBX 301. Similarly the data protocol used on the in-house wiring may be varied from embodiment to embodiment, depending on compatibility with the CSMA/CD-type network management provided on the in-house wiring. Design and placement of converter boxes may vary as well, and there are a number of alternatives in the way power for internal components may be supplied. The differences are numerous, and the invention is limited only by the breadth of the claims which follow.